

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 13 FEB 2005

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Applicant's or agent's file reference XA1821	FOR FURTHER ACTION		See Form PCT/IPEA/416
International application No. PCT/GB2004/004311	International filing date (day/month/year) 08.10.2004	Priority date (day/month/year) 17.10.2003	
International Patent Classification (IPC) or national classification and IPC G02F1/1333, G02F1/315			
Applicant MBDA UK LIMITED et al.			

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

3. This report is also accompanied by ANNEXES, comprising:

a. ☐ sent to the applicant and to the International Bureau a total of sheets, as follows:

☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).

☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒ Box No. I Basis of the opinion

☐ Box No. II Priority

☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability


☐ Box No. IV Lack of unity of invention

☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

☐ Box No. VI Certain documents cited

☐ Box No. VII Certain defects in the international application

☐ Box No. VIII Certain observations on the international application

Date of submission of the demand 17.06.2005	Date of completion of this report 10.02.2006
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Kiernan, L Telephone No. +49 89 2399-2185



INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/GB2004/004311

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
 - ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-3, 5-9	as originally filed
4, 4a	received on 16.01.2006 with letter of 12.01.2006

Claims, Numbers

1(part)	as originally filed
1(part), 2-6	received on 16.01.2006 with letter of 12.01.2006

Drawings, Sheets

1/5-5/5	as originally filed
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- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
 - ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
 - ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/GB2004/004311

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-6
	No: Claims	
Inventive step (IS)	Yes: Claims	1-6
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-6
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V.

- 1 The following documents are referred to in this International Preliminary Report on Patentability:

D1 : US 6 559 921 B1 (LESLIE THOMAS M ET AL) 6 May 2003 (2003-05-06)

D2 : US-A-5 132 822 (BUHRER CARL F) 21 July 1992 (1992-07-21)

2 **INDEPENDENT CLAIM 1**

Independent device claim 1 defines the structural features of a switchable coupler. The coupler is defined as having a first and second waveguide, each waveguide having a respective inlet port and outlet port and being arranged to receive first and second polarised light inputs. A polarization splitter device is positioned between the two waveguides to split both the first unpolarised light input and the second unpolarised light input, into respective refracted and reflected polarised components. The waveguides are arranged to transmit the reflected and refracted polarised components of the first light input by total internal reflection in the direction of the first outlet port and to transmit the reflected and refracted polarised components of the second light input by total internal reflection in the direction of the second outlet port. The device is further defined as having a first electro-optical switch positioned in the paths of the refracted and reflected polarised components of the first light input and recombines said components while switching the recombined optical signal towards the second outlet port. The device is further defined as having a second electro-optical switch positioned in the paths of the refracted and reflected polarised components of the first light input and recombines said components while switching the recombined optical signal towards the first outlet port.

Closest prior art document D2 discloses an optical switching device having 2 waveguides positioned on top of one another. Between the two waveguides (see for example fig. 6) there are two passive liquid crystal polarising beam splitters (see for example fig. 6, (97) and associated text) and a single active liquid crystal polarisation

combining switch (see for example fig. 6, (96) and associated text). The subject-matter of claim 1 differs from what is disclosed in D2 by the feature concerning the incorporation of a second electro-optical polarisation combining switch. This enables both unpolarised inputs to be coupled to a single output waveguide whereas D2 functions as a crossover polarisation independent optical switch. None of the prior art document, available to the Examiner suggest or anticipate the incorporation of a second polarisation combining optical switch. It is also not considered obvious for a person skilled in the art to modify the device disclosed in D2, in such a fashion, without exercising inventive skill. Therefore, the subject-matter of claim 1 (and dependent claims 2-5) is considered as satisfying the requirements of Article 33(1) PCT.

3. Claims 2-5 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.
4. The subject-matter of independent claim 6 is essentially the same as that of claim 1 in the form of a method. For the same reasons as outlined in point 2 above, the subject-matter of claim 6 is considered as fulfilling the requirements of Article 33(1) PCT.
5. The following defects have been noted by the Examiner:
 - 5.1 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in documents D1 and D2 is not mentioned in the description.
 - 5.2 The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

two separate cells, one liquid crystal cell serving to split the first unpolarised light input, and the other liquid crystal cell serving to split the second unpolarised light input.

5 The, or each, electro-optical switch preferably includes liquid crystal positioned between the waveguides, and an electric field device is provided to generate an electric field across the liquid crystal to operate the electro-optical switch, or switches. In this case the liquid crystal preferably defines two separate cells, one of these liquid crystal cells forming part of each electro-optical switch.

10 According to another aspect of the invention, A method of coupling unpolarised light comprising

receiving a first input of unpolarised light at an inlet port of a first waveguide, the first waveguide defining a first outlet port;

15 receiving a second input of unpolarised light at an inlet port of a second waveguide, the second waveguide defining a second outlet port;-

splitting the first and light second inputs into respective refracted and reflected polarised components,

20 transmitting the refracted and reflected components of the first input to a first electro-optical switch operable to recombine the refracted and reflected components of the first input and to switch the recombined output towards the second outlet port,

25 transmitting the refracted and reflected components of the second input to a second electro-optical switch operable to recombine the refracted and reflected components of the second input and to switch the recombined output towards the first outlet port, and

selecting the operation of the first and second electro-optical switches to couple the first and second inputs into either the first outlet or the second outlet.

30 The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

4a

Figure 1 is an enlarged side elevation of an optical coupler as taught by
this invention;

a second electro-optical switch is positioned in the paths of the refracted and reflected polarised components of the second light input, and

the second electro-optical switch is operable to recombine the refracted and reflected polarised components of the second light input and to switch these combined components to the first outlet port.

2. A switchable coupler, according to Claim 1, in which the polarisation splitter device includes liquid crystal positioned between the waveguides.
3. A switchable coupler, according to Claim 2, in which the liquid crystal defines two separate cells, one liquid crystal cell serving to split the first unpolarised light input, and the other liquid crystal cell serving to split the second unpolarised light input.
4. A switchable coupler, according to any preceding claim in which the, or each, electro-optical switch includes liquid crystal positioned between the waveguides, and an electric field device is provided to generate an electric field across the liquid crystal to operate the electro-optical switch, or switches.
5. A switchable coupler, according to Claim 4, in which the liquid crystal defines two separate cells, one of these liquid crystal cells forming part of each electro-optical switch.
6. A method of coupling unpolarised light comprising
receiving a first input of unpolarised light at an inlet port of a first waveguide, the first waveguide defining a first outlet port;
receiving a second input of unpolarised light at an inlet port of a second waveguide, the second waveguide defining a second outlet port;-
splitting the first and light second inputs into respective refracted and reflected polarised components,
transmitting the refracted and reflected components of the first input to a first electro-optical switch operable to recombine the refracted and reflected components of the first input and to switch the recombined output towards the second outlet port,

transmitting the refracted and reflected components of the second input to a second electro-optical switch operable to recombine the refracted and reflected components of the second input and to switch the recombined output towards the first outlet port, and

- 5 selecting the operation of the first and second electro-optical switches to couple the first and second inputs into either the first outlet or the second outlet.